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NTIA REPORT 92-285

92-9

FEDERAL SPECTRUM USAGE OF THE 1710-1850 AND 2200-2290 MHz BANDS

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U.S. DEPARTMENT OF COMMERCE • National Telecommunications and Information Administration



ADDENDUM to NTIA REPORT 92-285

This Addendum has been prepared to provide the reader, additional information regarding government operations in the 1710-1850 MHz and 2200-2290 MHz bands. It should be noted that the frequency assignments authorized by NTIA do not, in general, represent the number of equipments associated with that assignment. In addition, NTIA, after consultations with affected government agencies, has determined that the government band at 2200-2290 MHz is available only for Federal Government use due to national security reasons.

This report indicates that in the 1710-1850 MHz band, a total of 5539 frequency assignments had been authorized by NTIA in this band as of March 1990. These assignments, as indicated, are authorized for a wide range of fixed, mobile, and space communication services. These include applications such as national defense, power distribution, resource management, public safety and law enforcement, air and land combat training, and satellite tracking and control. In addition, there are classified uses of this band that are not included in the calculation of government utilization of these frequencies. Depending on the specific service, these authorized frequency assignments may represent one transmitter or many transmitters. More specifically, the largest number of assignments, almost 5000, are for conventional fixed microwave systems. These conventional fixed microwave systems are primarily one transmitter per assignment. A small number of the fixed assignments are for the military area-wide transportable radio relay systems. These few assignments represent approximately 3000 transportable transmitters in the Federal Government inventory. Each of the 400 mobile service assignments represent approximately 10 transmitters, for a total of 4000 mobile service transmitters. Including the Earth station and experimental assignments, over 12,000 transmitters with an estimated value of over \$10 billion are operated by Federal agencies in the 1710-1850 MHz band.

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ERNESTO A. CEREZO

92-91



U.S. DEPARTMENT OF COMMERCE
Barbara Hackman Franklin, Secretary

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ABSTRACT

This Spectrum Resource Assessment (SRA) is an integral part of the National Telecommunications and Information Administration (NTIA), Office of Spectrum Management (OSM) long-range planning process related to national and international interests that focus on radio frequency spectrum topics. The SRA includes a description of the current Federal Government spectrum use of the 1710-1850 MHz and 2200-2290 MHz bands and an estimate of the Federal Government investment in these bands.

Specifically, the SRA provides updated information on allocations, technical standards, frequency assignments, channeling plans and spectrum usage of the 1710-1850 MHz and 2200-2290 MHz bands. It also includes updated information on major systems currently operating or planned for operation in these bands and their technical or operational characteristics.

Note, however, that pertinent information related to Government spectrum use and investment included in this report are based solely on unclassified frequency assignments or systems authorized for use in these bands.

KEY WORDS

1710-1850 MHz Band
2200-2290 MHz Band
Earth Exploration Service
Fixed Service
Mobile Service
Radio Astronomy Service
Space Operations Service
Space Research Service
Space Systems
Spectrum Usage

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CONTENTS

SECTION 1 INTRODUCTION

	Page
BACKGROUND	1-1
OBJECTIVES	1-3
APPROACH	1-3

SECTION 2 SUMMARY OF FINDINGS

INTRODUCTION	2-1
1710-1850 MHz Band	2-2
2200-2290 MHz Band	2-4

SECTION 3 RULES AND REGULATIONS

ALLOCATION RULES	3-1
1710-1850 MHz Band	3-1
2200-2290 MHz Band	3-4
TECHNICAL STANDARDS	3-6
FREQUENCY CHANNELING PLANS	3-8

SECTION 4 SPECTRUM USAGE

1710-1850 MHz BAND	4-1
Background	4-1
Spectrum Usage	4-3
Spectrum Use Measure (SUM) in the Continental U.S. (CONUS)	4-8
Emission Characteristics	4-12
2200-2290 MHz BAND	4-12
Background	4-12
Spectrum Usage	4-15
Spectrum Use Measure (SUM) in the Continental U.S. (CONUS)	4-19
Emission Characteristics	4-25

CONTENTS
(continued)

SECTION 5
SUMMARY OF MAJOR SYSTEMS IN THE 1710-1850 MHz BAND

	Page
INTRODUCTION	5-1
GENERAL	5-1
MAJOR SYSTEMS OPERATING OR PLANNED FOR OPERATION IN THE 1710-1850 MHz BAND	5-6
SPACE SYSTEMS	5-6
FIXED SERVICE	5-22
MOBILE SERVICE	5-26
RADIO ASTRONOMY SERVICE	5-36
EXPERIMENTAL	5-37

SECTION 6
SUMMARY OF MAJOR SYSTEMS IN THE 2200-2290 MHz BAND

INTRODUCTION	6-1
GENERAL	6-1
MAJOR UNCLASSIFIED SYSTEMS OPERATING OR PLANNED FOR OPERATION IN THE 2200-2290 MHz BAND	6-7
SPACE SYSTEMS	6-7
SPACE RESEARCH SERVICE	6-11
EARTH EXPLORATION SERVICE	6-17
SPACE OPERATION SERVICE	6-18
FIXED SERVICE	6-20
MOBILE SERVICE	6-21
EXPERIMENTAL	6-27

APPENDICES

APPENDIX A: ESTIMATED FEDERAL GOVERNMENT'S INVESTMENT FOR FIXED SYSTEMS IN THE 1710-1850 MHz AND 2200-2290 MHz BANDS	A-1
APPENDIX B: COORDINATION CONTOUR FOR TRANSMITTING EARTH STATIONS IN THE 1761-1842 MHz BAND	B-1
APPENDIX C: COORDINATION CONTOUR FOR RECEIVING EARTH STATIONS IN THE 1761-1842 MHz BAND	C-1

CONTENTS
(continued)

Page

REFERENCES

REFERENCES R-1

LIST OF TABLES

TABLE

2-1	ESTIMATED TOTAL FEDERAL GOVERNMENT'S INVESTMENT FOR THE 1710-1850 MHz AND 2200-2290 MHz BANDS	2-1
2-2	GMF ASSIGNMENTS BY AGENCY IN THE 1710-1850 MHz BAND	2-3
2-3	GMF ASSIGNMENTS BY AGENCY IN THE 2200-2290 MHz BAND	2-5
3-1	CURRENT INTERNATIONAL AND U.S. NATIONAL TABLES OF FREQUENCY ALLOCATIONS FOR THE 1710-1850 MHz BAND	3-2
3-2	TRANSMITTING EARTH STATIONS IN THE 1710-1850 MHz BAND	3-3
3-3	CURRENT INTERNATIONAL AND U.S. NATIONAL TABLES OF FREQUENCY ALLOCATIONS FOR THE 2200-2900 MHz BAND	3-5
3-4	RECEIVING EARTH STATIONS IN THE 2200-2290 MHz BAND	3-6
3-5	FREQUENCY TOLERANCE AND UNWANTED EMISSION TECHNICAL STANDARDS FOR THE 1710-1850 MHz AND 2200-2290 MHz BANDS	3-7
3-6	SUMMARY OF TECHNICAL STANDARDS APPLICABLE TO THE FIXED SERVICE IN THE 1710-1850 MHz AND 2200-2290 MHz BANDS ...	3-9
4-1	SUMMARY OF PARAMETERS FOR SYSTEMS IN THE 1710-1850 MHz BAND	4-4
4-2	SUMMARY COUNT OF STATION CLASSES PER AGENCY, AND SERVICE IN THE 1710-1850 MHz BAND, AS OF APRIL 1990	4-5

CONTENTS
(continued)

LIST OF TABLES
(continued)

TABLE		Page
4-3	EMISSION DESIGNATORS AND STATION CLASS PREDOMINANTLY USED BY EACH AGENCY IN THE 1710-1850 MHz BAND	4-14
4-4	SUMMARY OF PARAMETERS FOR SYSTEMS IN THE 2200-2290 MHz BAND	4-16
4-5	SUMMARY COUNT OF STATION CLASSES PER AGENCY AND SERVICE IN THE 2200-2290 MHz BAND, AS OF MARCH 1990	4-18
4-6	EMISSION DESIGNATORS AND STATION CLASS PREDOMINANTLY USED BY EACH AGENCY IN THE 2200-2290 MHz BAND	4-27
5-1	SUMMARY LIST OF MAJOR UNCLASSIFIED SYSTEMS IN THE 1710-1850 MHz BAND AND ESTIMATED FEDERAL GOVERNMENT'S INITIAL AND REPLACEMENT COSTS	5-2
5-2	SUMMARY OF KEY SYSTEM PARAMETERS IN THE 1710-1850 MHz AND 2200-2290 MHz BANDS	5-7
5-3	COMMAND AND TELEMETRY FREQUENCY RELATIONSHIP FOR SGLS	5-11
5-4	LONGITUDINAL POSITIONS OF THE FLTSATCOM-C SATELLITES	5-12
5-5	BASIC OPERATIONAL CHARACTERISTICS OF THE TACTICAL AND TRAINING RADIO RELAY EQUIPMENT OPERATING IN THE 1710-1850 MHz BAND	5-25
5-6	RADIO LINK REQUIREMENTS FOR THE ACMI/ACMR	5-31
5-7	FALLON AND CHARLESTON NAS TACTS FREQUENCY USAGE	5-34
6-1	SUMMARY LIST OF MAJOR SYSTEMS OPERATING OR PLANNED FOR OPERATION IN THE 2200-2290 MHz BAND AND ESTIMATED FEDERAL GOVERNMENT'S INITIAL AND REPLACEMENT COSTS	6-2

CONTENTS (continued)

LIST OF FIGURES

Figure		Page
4-1	Geographic distribution of assignments in the 1710-1850 MHz band	4-6
4-2	Frequency assignment distribution per state in the 1710-1850 MHz band	4-7
4-3	Frequency assignment distribution per MHz Bin in the 1710-1850 MHz band	4-9
4-4	Areas of the United States with various ranges of spectrum use bandwidth (SUB) values in the 1710-1850 MHz band	4-10
4-5	Areas of the United States with various ranges of Spectrum Use Factor (SUF) values in the 1710-1850 MHz band	4-11
4-6	Distribution of emission bandwidths in the 1710-1850 MHz band	4-13
4-7	Geographic distribution of assignments in the 2200-2900 MHz band	4-20
4-8	Frequency assignment distribution per state in the 2200-2290 MHz band	4-21
4-9	Frequency assignment distribution per Megahertz Bin in the 2200-2290 MHz band	4-22
4-10	Areas of the United States with various ranges of spectrum use bandwidth (SUB) values in the 2200-2290 MHz band	4-23
4-11	Areas of the United States with various ranges of Spectrum Use Factor (SUF) values in the 2200-2290 MHz band	4-24
4-12	Distribution of emission bandwidths in the 2200-2290 MHz band	4-26
5-1	Pictorial representation of major systems in the 1710-1850 MHz and 2200-2290 MHz bands	5-9
5-2	Space Shuttle Communication Links	5-13

CONTENTS
(continued)

LIST OF FIGURES
(continued)

Figure		Page
5-3	FLTSATCOM-C line diagram	5-15
5-4	Operational configuration of the DSCS-III System	5-16
5-5	Some of the Potential Applications of the GPS	5-19
5-6	U.S. Coast Guard Vessel Traffic System at New York	5-24
5-7	Generalized Structural Model of a Packet Radio Network	5-27
5-8	SEEK Skyhook line diagram	5-29
5-9	Typical configuration of a TACTS deployment	5-33
6-1	Typical AN/USQ-X Scoring System Configuration	6-24

EXECUTIVE SUMMARY

Overview

The National Telecommunications and Information Administration (NTIA) serves as the President's principal advisor on telecommunications policies pertaining to the Nation's economic and technological advancement and to the regulation of the telecommunications industry. It also serves as manager to the Federal Government's use of the radio frequency spectrum. NTIA's responsibilities include establishing policies concerning spectrum assignment, allocation and use, and providing the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with policies as mandated in the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management. As part of these responsibilities, NTIA conducted a spectrum resource assessment of the Executive Branch's current and planned use of the 1710-1850 MHz and 2200-2290 MHz frequency bands considering current NTIA, congressional, international, marketplace, and technology initiatives.

This report addresses regulatory aspects for both bands; summarizes the Federal Government's current and future spectrum use; identifies the Federal Government's requirements and services provided to benefit the public; and provides the estimated Federal Government's investment for both bands.

Federal Government Missions

The Federal Government, by various public laws and international treaty agreements, performs a variety of missions such as:

- National Defense
- Developing, managing, conserving and protecting national resources.
- Promoting full development of economic resources.
- Managing, administering, and conserving energy resources.
- Managing emergency preparedness, mitigation and response activities.
- Administering and protecting Federal property.

- Representing the public in enforcing Federal laws.
- Conducting research and development in the space sciences.
- Developing national transportation programs.
- Managing the operation of the National Air Space System.
- Adhering to commitment established by international treaty agreements relating to space and terrestrial radiocommunications.

Federal Government Services

The Federal Government, in partnership with industry, is committed to providing required services to the public. In order to provide these services, the Federal Government requires reliable and cost-effective telecommunications systems. The majority of the Federal Government's telecommunications is provided by commercial entities. However, in those instances where commercial telecommunications systems are unavailable, or not adequate from a technical or operational standpoint, or significantly more costly, separate Government telecommunications systems are established.

In the 1710-1850 and 2200-2290 MHz bands, telecommunications systems for normal and emergency operational purposes provide the following typical services to the public:

- Comprehensive and realistic training of military air and land mobile forces.
- Managing remote National Parks, National Forests, and Federal Wildlife Refuges.
- Generating and distributing electrical power to utilities and industry in 23 Central, Southwestern and Western States.
- Providing early warning to the public from major catastrophic events.
- Controlling vessel traffic in major port areas.
- Promoting aviation safety and efficiency.
- Enforcing drug interdictions, customs, and immigration laws.
- Conducting search and rescue operations.
- Providing support to the National Airspace System.

- Exchanging social, environmental, health, and educational information between countries of the Pacific Basin.
- Conducting studies and experiments through various space programs relating to defense, scientific, environmental, commercial, and international interests.
- Collecting weather information from satellites and distributing this real-time information to radio and television broadcast stations.
- Fostering advances in weather and climate research through the Mission to Planet Earth Program.
- Verifying compliance with international treaty agreements concerning nuclear explosions and arms control.
- Mapping the Planet Earth from LANDSAT.
- Informing and educating the public of global ocean circulation by making precise and accurate measurements of sea level.
- Supporting nuclear waste management program.
- Cost effective real-time transmission of test data from military research and development projects.

Current Spectrum Resources Use

The Federal Government relies heavily on both bands to provide beneficial public services and to satisfy its telecommunications requirements because of the following:

- These bands are the primary frequency bands which support low- and medium-capacity fixed microwave systems throughout the Federal Government for numerous purposes, especially those Government microwave networks operating in remote regions of the Continental United States.
- The 1710-1850 MHz is the primary tracking, telemetry and command (TT&C) uplink band for military satellite systems. This will continue for at least the next 20-30 years. The large U.S. space program investment in this frequency band is manifested in ground-based TT&C facilities and associated spacecraft either in storage awaiting launch or currently in orbit. In addition there is a requirement for the TT&C links to be compatible with the spacecraft of other nations. Uplink frequency assignments supporting TT&C have increased 36 percent or more within the last decade.

- The 2200-2290 MHz is the primary TT&C downlink band for Federal Government satellite systems operating on the 1710-1850 MHz and 2025-2110 MHz uplink bands. This will continue for at least the next 20-30 years. The large U.S. space program investment in these frequency bands is manifested in ground-based TT&C facilities and associated spacecraft either in storage awaiting launch or currently in orbit. In addition, there is a requirement for the TT&C links to be compatible with the spacecraft of other nations. Of the total radio service operations in the band, about 36 percent are for satellite downlink operations.
- Both bands support numerous fixed and highly mobile military tactical communication systems. Constant training is required to maintain operator proficiency and equipment readiness in case of emergency.
- Although other frequency bands exist for fixed, mobile and space radio services, these frequency bands are the best bands for these specific operations from an efficiency, economy standpoint and terrain considerations. In the 1710-1850 MHz band, about 87 percent of the total frequency authorizations are in the fixed service and, in the 2200-2290 MHz band, approximately 63 percent of the total frequency authorizations are for mobile and various space services.
- Radio astronomy observations are being carried out at several facilities in the United States on the spectral line due to the hydroxyl radical (OH) at a rest frequency of 1720.530 MHz.
- Federal Government frequency assignment growth rate in the last decade is averaging approximately 15 percent and 4 percent per year in the 1710-1850 MHz and 2200-2290 MHz bands, respectively. These trends are expected to continue into the 21st century. Note, however, that space operation activities, which predominate in the 2200-2290 MHz band, cannot be evaluated alone by the increase or decrease of the number of assignments in the band but, also, by frequency bandwidth per use.
- The Federal Government's current investment for all services, facilities and systems in these bands is approximately \$45 Billion. It should be noted that this value does not include classified systems in both bands and only reflects those systems with cost information. In addition, the cost does not include operational impacts such as research and development, test and evaluation and operations and maintenance factors. Thus, the \$45 billion estimate is low resulting in an overall larger impact in non-recurring costs only.
- Development of advanced weapons depends upon real-time transmission of test telemetry and precision timing signals in both frequency bands.

SECTION 1

INTRODUCTION

BACKGROUND

The National Telecommunications and Information Administration (NTIA) is responsible for managing the Federal Government's use of the radio frequency spectrum. NTIA's responsibilities include establishing policies concerning spectrum assignment, allocation and use, and providing the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with these policies.¹ In support of these responsibilities, NTIA has undertaken a number of spectrum resource assessments (SRAs). The objectives of these studies were to assess spectrum utilization, identify existing and/or potential compatibility problems between systems of various departments and agencies, provide recommendations for resolving any compatibility conflicts, and recommend changes to promote efficient and effective use of the radio spectrum and to improve spectrum management procedures.

This SRA is an integral part of the NTIA Office of Spectrum Management (OSM) long-range planning process related to national and international interests that focus on radio frequency spectrum topics. The SRA includes an estimate of the Federal Government's investments in the 1710-1850 MHz and 2200-2290 MHz bands. The estimate, however, is just based on unclassified frequency assignments or systems that are authorized for use in these bands.

Member countries of the International Telecommunications Union (ITU), including the United States, are preparing for the 1992 World Administrative Radio Conference (WARC-92) of the ITU. The ITU established an agenda which will consider additional allocations for mobile and mobile-satellite services in the 1-3 GHz frequency range and an allocation for the sound broadcasting-satellite service (BSS sound) within the 500-3000 MHz band. This report, in general, addresses the national spectrum use and supports the WARC-92 preparations within NTIA.

In the U.S., a developing technology commonly referred to as "personal communications service or network" (PCS/PCN) has gained considerable recognition within the private telecommunications community. Several private industries have petitioned the Federal

¹ NTIA, *Manual of Regulations and Procedures for Federal Radio Frequency Management*, U.S. Department of Commerce, National Telecommunications and Information Administration, Washington, D.C., May 1989 Edition, Revised January 1990.

Communications Commission (FCC) to allocate frequencies below 2300 MHz for the operation of a PCS or PCN.² There is also a bill (Emerging Telecommunications Technology Act of 1991) being considered within the 91st Congress which proposes to reallocate at least 200 MHz of spectrum below 5000 MHz from the exclusive use of the Federal Government to nongovernment sector. This report provides current and unclassified information on the Federal Government's spectrum uses and major systems operating or planned for operation in the 1710-1850 MHz and 2200-2290 MHz bands. It serves as a tool for any coordination between the government and non-government sectors pertaining to these bands.

In addition, NTIA occasionally updates reports that contain obsolete information that are relevant to current and significant international or national issues. NTIA had previously addressed the 1710-1850 MHz and 2200-2300 MHz bands in detailed SRAs.^{3,4} However, the reports are over a decade old. There had been some changes, deletions, and additions to the International and National Allocations, as well as the associated footnotes for both bands, as a result of the 1979 WARC. Since both SRAs were published before the implementation of the Final Acts of the 1979 WARC, there is a requirement that these SRAs be updated.

Such national and international activities emphasize the need to investigate the reallocation of all or part of the 1700-2300 MHz frequency range for these new offerings. The entire 1700-2300 MHz band, however, is very heavily used by both government and non-government users. In the 1710-1850 MHz and 2200-2290 MHz bands alone, approximately 8,000 assignments are registered in the Government Master File (GMF). The average growth of new assignments per year for the 1710-1850 MHz and the 2200-2290 MHz bands are about 400 and 80 assignments, respectively. Moreover, both bands support a wide variety of systems thereby significantly complicating any sharing considerations if another service were to be introduced into the bands.

Also worthwhile for consideration is the fact that the 1710-1850 MHz is the established band for uplink tracking, telemetry and command (TT&C) in the U.S., and the 2200-2290 MHz is the international choice for downlink TT&C for space systems. One reason for this is the law of physics attributed to these bands in terms of signal propagation characteristics (e.g., low noise

² Federal Communications Commission's Notice of Inquiry, General Docket No. 90-314, FCC 90-232, June 28, 1990.

³ Hurt, G. and Crandall, G., *Spectrum Resource Assessment in the 1710-1850 MHz Band*, NTIA-TM-79-26, U.S. Department of Commerce, November 1979.

⁴ Flynn, F., *Spectrum Resource Assessment in the 2200-2300 MHz Band*, NTIA Report 80-48, U.S. Department of Commerce, September 1980.

temperature and good atmospheric and rain attenuations). In addition, there are international agreements between the U.S. and numerous countries that exist for joint ventures that require space networks' interoperability. Reallocating the TT&C for space systems to other frequency bands would cause major cost and mission impacts including making these systems incompatible with the space systems used by many other nations.

The portions of the spectrum under study in this report are the 1710-1850 MHz and 2200-2290 MHz bands. Nationally, both bands are allocated for use by stations in the fixed and mobile services and certain space operations on primary co-equal bases either by allocation or by footnotes.

OBJECTIVES

The objectives of this study were: (1) to update past unclassified studies of the 1710-1850 MHz and 2200-2290 MHz bands in order to provide information addressing current issues related to these frequency bands, and (2) to provide an estimate of the Federal Government's investment in these bands, taking into account unclassified systems only.

APPROACH

To accomplish the objectives of the task, the following approach was undertaken.

1. Reviewed existing rules and regulations, technical standards, channeling plans (if applicable), and determined band usage for both bands.
2. Identified current unclassified systems operating in the bands, their deployment, and associated technical characteristics by using the GMF, previous NTIA reports, and other government documents.
3. Identified future unclassified systems to be deployed in the bands by using the data in the GMF and the Interdepartment Radio Advisory Committee/Spectrum Planning Subcommittee system review file, previous NTIA reports and information supplied by Federal agencies.

4. Evaluated the inputs provided by the government agencies to the NTIA memorandum with regards to economic investment for unclassified telecommunication systems in the 1710-1850 MHz and 2200-2290 MHz bands.⁵

⁵ NTIA, OSM Memorandum to the IRAC Representatives, "*Government Spectrum Usage Information*," February 11, 1990.

SECTION 2 SUMMARY OF FINDINGS

INTRODUCTION

An assessment of the current uses of the 1710-1850 MHz and 2200-2290 MHz bands and applicable band or spectrum usage, technical standards, regulations and procedures, and channeling plans for these bands has been completed. The study included the identification of existing unclassified systems operating in the band, as well as planned unclassified systems. The summary of findings is based on the assessment of data from the Government Master File (GMF), previous band studies of the 1710-1850 MHz and 2200-2300 MHz, the NTIA Manual, discussions with NTIA personnel, and Federal agencies' documents.

In general, the two bands support major fixed, mobile and space systems within virtually all Federal agencies. The 1710-1850 MHz band is the primary medium capacity, fixed microwave band used by the Federal Government. In addition, the band is also the primary tracking, telemetry and command (TT&C) uplink band for Federal Government satellite systems. The average annual frequency assignment growth rate in the band is about 15% (i.e., 1250 assignments in December 1978 to 5539 assignments in March 1990). The 2200-2290 MHz band is the primary TT&C downlink band for all Federal Government satellite systems and has become one of the principal bands supporting mobile telemetering for military operations. The average annual frequency assignment growth rate in this band is about 4% (i.e., 1452 assignments in January 1980 to 2170 in June 1990). It should be recognized, however, that space operation activities which predominate in the 2200-2290 MHz band can not be measured alone by the decrease or increase of frequency assignments in the band, but also by the magnitude of the frequency bandwidth per use. An estimate of the initial and replacement costs of unclassified systems operating in both bands is provided in TABLE 2-1.

TABLE 2-1

ESTIMATED TOTAL FEDERAL GOVERNMENT'S INVESTMENT FOR THE 1710-1850 MHz AND 2200-2290 MHz BANDS

System Type	Estimated Total Initial Cost (Billions)	Estimated Total Replacement Cost (Billions)
Space	25.52	36.69
Fixed	0.71	1.14
Mobile	18.20	19.00
Radio Astronomy	0.07	0.11

The estimated total initial and replacement costs for the space, fixed, mobile, and radio astronomy systems are derived from TABLES 5-1 and 6-1. The investment costs, listed in TABLE 2-1 for the various systems, usually includes the cost of the equipment (e.g., transmitter, receiver, tower, etc.) or unit (e.g., satellites, launch vehicles, etc.), including land acquisition and equipment or facility installation for the fixed line-of-sight, point-to-point systems. It should be noted, however, that the total costs only reflect those systems with cost information. The procedure used to estimate the Federal Government's investment for fixed line-of-sight, point-to-point systems in both bands is delineated in Appendix A. The appendix also includes some pertinent documents in which the costs were derived from. There are some cases, however, where the estimated initial cost specified by an agency for a fixed system differs from the cost stated in either TABLE 5-1 or TABLE 6-1. This is because, in both tables, the actual fixed assignments count was used as the number of stations or units as opposed to the agency's assumed number of stations.

The growth trend in the 1710-1850 MHz band, and the continued capital investment into space systems in the 2200-2290 MHz band, definitely indicates the continued importance of these bands to the Federal Government and the entire nation.

1710-1850 MHz Band

- a. Nationally, the 1710-1850 MHz band is allocated exclusively to the Federal Government for the fixed and mobile services on a primary basis with the Earth-to-space transmissions for certain space operations being accommodated on a co-equal basis in the 1761-1842 MHz portion of the band. Footnotes 722, US256 and G42 apply.
- b. Internationally, the 1710-1850 MHz range is allocated exclusively for fixed and mobile services in Regions 1, 2, and 3 on a primary, co-equal basis, except in Region 1 where the mobile is secondary to the fixed service.
- c. Internationally, Earth-to-space transmissions in the 1750-1850 MHz frequency range is allowed in Region 2 and several other countries for space operation and space research services.
- d. Radio astronomy observations are being carried out at several facilities in the United States on the spectral line due to the hydroxyl radical (OH) at a rest frequency of 1720.530 MHz on an unprotected basis.
- e. The 1710-1850 MHz band is the predominant federal medium-capacity fixed point-to-point band. The fixed is the predominant service used in the band. About 87% of the total assignments in the band are for systems operating in the fixed service.

- f. Currently, 22 agencies have assignments in this band. The primary users of the band are shown in TABLE 2-2.

TABLE 2-2

GMF ASSIGNMENTS BY AGENCY IN THE 1710-1850 MHz BAND

Agency	Number of Assignments	Percent of Total Assignments ^a
Agriculture	1373	25
Army	790 ^b	14
Justice	722	13
Energy	652	12
Air Force	640	12
Navy	450	8
Others	912	16

^aThe percentages of the total assignments are rounded-off.

^bDoes not include the temporary assignments that support the area-wide command and control network system.

- g. Over the past 11 years, the number of assignments has increased almost fivefold. The average annual assignment growth rate in the band is approximately 15%.
- h. A wide variety of systems are employed in the band characterized by at least 36 emission types and a range of authorized emission bandwidths from 40 kHz to 70 MHz. The most predominant emission type is F9W (FDM/FM) and the most common bandwidths range from 800 kHz to 10 MHz (see Figure 4-6).
- i. Although there is no NTIA sanctioned channeling plan in the band, the discrete distribution of frequency assignments occurs generally at every 5 MHz intervals starting at 1710 MHz (See Figure 4-3).
- j. The number of Space Ground Link Subsystem uplink assignments to support the tracking, telemetry, and control of DOD orbiting satellites has increased 36% from December 1978 to March 1990.
- k. The 1710-1850 MHz is the predominant band used by the Army for command and control employing an area-wide grid network system. Typically, there are over 200 communication links for an area network system. The frequency assignments supporting these links are not recorded in the GMF.

2200-2290 MHz Band

- a. Nationally, the 2200-2290 MHz band is allocated exclusively to the Federal Government for fixed, mobile, and space research services on a primary basis. The use of the fixed and mobile services, however, is limited to line-of-sight operations including aeronautical telemetering but excluding testing of manned aircraft. Footnotes US303 and G101 apply.
- b. Internationally, the 2200-2290 MHz band is also allocated exclusively for fixed and mobile services to Regions 1, 2, and 3 on a primary basis, except in Region 1 where the mobile is secondary to the fixed service.
- c. Nationally, the space-to-Earth and space-to-space transmissions in the space operations and earth exploration-satellite services may be accommodated on a co-equal basis with the fixed, mobile, and space research services.
- d. Internationally, the frequency range 2200-2290 MHz may also be used for space-to-Earth and space-to-space transmissions in the space research, space operation and earth exploration-satellite services; however, only under certain conditions set forth by the International Telecommunications Union (ITU).
- e. Also, under certain conditions set forth by the ITU, non-government space stations in the space research, space operation and earth exploration-satellite services may be authorized to transmit to the Tracking and Data Relay Satellite System in the band segment 2285-2290 MHz.
- f. About 63% of the total assignments are for mobile and various space services. The majority supports mobile telemetry and satellite downlink or space-to-space telemetry operations.
- g. Currently, 17 agencies have assignments in the band. The primary users of the band are shown in TABLE 2-3.

TABLE 2-3

GMF ASSIGNMENTS BY AGENCY IN THE 2200-2290 MHz BAND

Agency	Number of Assignments	Percent of Total Assignments*
Air Force	888	41
Navy	427	20
Army	354	16
Energy	212	10
NASA	147	7
Others	143	7

*The percentages of the total assignments are rounded-off.

- h. The 10-year frequency assignment growth rate (4% annually) for the band is much lower than the growth rate in the 1710-1850 MHz band.
- i. This band also supports a wide variety of systems with 42 unique emission types and a range of emission bandwidths from 10 Hz to 40 MHz. The most common emission types employed are for mobile and space downlink telemetry operations and the most common bandwidths range from 600 kHz to 6 MHz (see Figure 4-12).
- j. Terrestrial telemetry functions are primarily transmissions from unmanned airborne platforms such as remotely piloted vehicles, drones, and missiles. The majority of these assignments are located at military test ranges in the Southwest U.S. and on the East Coast.

SECTION 3 RULES AND REGULATIONS

ALLOCATION RULES

1710-1850 MHz Band

Internationally, the 1710-1850 MHz frequency range is allocated to Regions 1, 2, and 3 for fixed and mobile services on a shared primary basis, except in Region 1 where the mobile service is secondary to the fixed service. The international footnotes applicable to each region are listed in TABLE 3-1. These footnotes are described in Chapter 4 of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (NTIA Manual).

Nationally, the 1710-1850 MHz band is also allocated for fixed and mobile services on a shared primary basis to Federal Government agencies. Excerpts from the U.S. National Table of Frequency Allocations show the international and national allocations of the 1710-1850 MHz frequency range, as depicted in TABLE 3-1. TABLE 3-1 includes the footnotes applicable to the U.S. and the frequency allotment plan applicable to the band. The allotment plan provides for the accommodation of fixed security surveillance systems on specific frequencies. These frequencies are enumerated in Section 4.2 of the NTIA Manual.

A portion of the band, 1761-1842 MHz, is designated for Earth-to-space transmissions for certain space operations and may be accommodated on a co-equal basis with services having primary status in the band. However, specific frequencies required to be used at any location will be satisfied on a coordinated case-by-case basis (Footnote G42).

In the segment 1718.8-1722.2 MHz of the 1710-1850 MHz band, radio astronomy observations are conducted in specific geographic areas listed under Footnote US256. However, since these astronomical observations are performed on an unprotected basis, Footnote US256 made provisions that agencies, in particular those using the 1718.8-1722.2 MHz range and operating within the specified radio astronomy observation sites, are "encouraged to minimize potential interference to the observations insofar as it is practicable." The existing International Footnote 722 provides that some countries are conducting passive research for the search of intentional emissions of extra-terrestrial origin in the low end of the band, 1710-1727 MHz.

In addition to these specific allocation rules and regulations, the NTIA Manual identifies frequency assignment procedures that are specifically applicable to this band as follows: